631.0502 Logging earth materials

Logging is the recording of data concerning the materials and conditions in individual test holes, pits, trenches, or exposures. Logging must be accurate so that the results can be properly evaluated to provide a true concept of subsurface conditions. It is equally imperative that recorded data be concise, complete, and presented in descriptive terms that are understood and evaluated in the field, laboratory, and design office. Logging is the geologic description of the material between specified depths or elevations. This description includes information such as name, texture, structure, color, mineral content, moisture content, relative permeability, age, and origin, plus any information that indicates engineering properties of the materials. Examples are gradation, plasticity, and the Unified Soil Classification System (USCS) symbol. In addition, the results of any field tests such as the standard penetration test (SPT) blow count must be recorded along with the specific vertical interval tested.

Information should be plotted to scale and located both vertically and on the applicable cross section or profile on form SCS–35 or equivalent. Correlation and interpretation of these graphic logs indicate the need for any additional test holes and their location, permit the plotting of stratigraphy and structure, and are the basis for development of complete geologic profiles.

(a) Graphic logs

Graphic logs are plotted at their correct location and elevation on forms NRCS–35A, 35B, and 35C, Plan and Profiles for Geologic Investigation, or their equivalents. Graphic logs must be plotted to scale and accurate elevation. Use mean sea level (MSL) for the reference plane, if possible, or an assumed datum if MSL is not known. Graphic columns that are off the centerline profile may show as being above or below the ground level of the profile, depending on the ground elevation of the boring. In this event, make a notation at the top of the column that shows the location relative to the centerline of the profile.

Indicate the location of the static water table by a tick mark at the correct elevation and record the date of measurement. Show the USCS symbol next to each stratum on the graphic column as a further guide to interpretation and sample requirements. To left of the graphic log, record the SPT blow count opposite the specific horizon tested. Use adjectives and their abbreviations given in the legend on form SCS–35A or equivalent for other salient features of the material, for example, wet, hard, mas. (massive). On both plans and profiles, number the holes according to their location. Use the numbering system from NEH631.02, table 2–2. On plans, show the location of holes by the proper symbol and indicate whether the hole was sampled.

(1) Recommended scales

The horizontal scale used should allow the graphic logs to be spaced far enough apart for the necessary information to be shown legibly. The vertical scale used should also allow the vertical sequence to be depicted adequately. The scales shown in table 5–1 are recommended for the different features of a site.

(2) Geologic profile

Develop tentative correlation lines as soon as possible. This helps to determine where additional test holes are needed. As more graphic logs are plotted, the stratigraphic relationships become more definite.

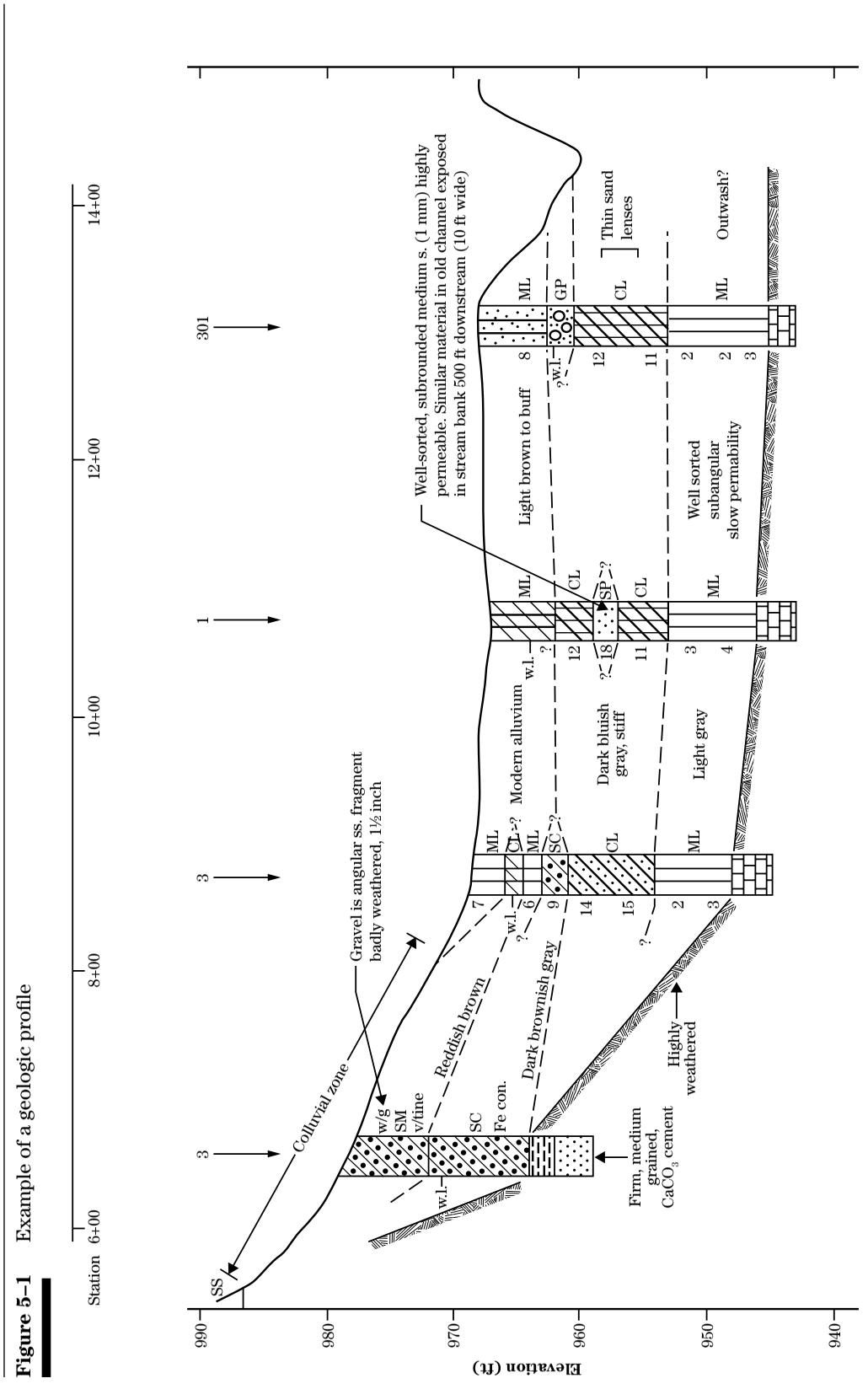
Interpretation of data in terms of the genetic classification of the deposits helps to establish correlation. Conversely, development of the geologic profile often helps to interpret the origin of the deposits. When the geologic profile is complete, it provides an interpretation of the factual information from the logs in terms of the stratigraphic and structural relationships along the plotted profile. To this profile, add notations on important conditions or characteristics such as groundwater level, permeability, density, genesis, sorting, degree of weathering or cementation, upstream and downstream mineralogy, and rock structure.

Figure 5–1 shows part of the geologic profile along the centerline of a proposed structure and illustrates some of these points. Plot profiles or sections drawn normal to the direction of streamflow as though the observer is looking downstream. Plot those drawn parallel to the direction of streamflow so that streamflow is from left to right.

Table 5–1 Recommended scales for plotting logs of earth materials

Vertical	1 in = 10 ft increase to 1 in = 5 ft for special situations, such as complex logs where thin horizons need to be delineated accurately		
Horizontal	Plan of site (all components)		1 in = 100 ft
	Profiles	Centerline of dam, auxiliary spillway, and borrow grids	1 in = 100 ft
		Centerline of principal spillway and the stream channel below the outlet end of the principal spillway	1 in = 50 ft
		Centerline of foundation drains, relief-well collector lines, and sediment-pool drain lines	1 in = 50 ft
		Cross section of stream channel	1 in = 20 ft. A scale that requires no more than 2 in for the plotted bottom width and no more than 6 in for the entire cross section
		Cross section of auxiliary spillway	1 in = 20 ft to 1 in = 100 ft. A scale that results in a plotted bottom width of at least 2 in

Figure 5–1 Example of a geologic profile



(b) Written logs

Form SCS–533

For written logs for engineering purposes, use Form SCS–533, Log of Test Holes, and Form SCS–533A, Continuation Sheet. These logs are prepared from field notes and are limited to factual information and data collected. These detailed logs include common narrative descriptions of the materials in easily understood terms.

Form SCS–533 provides space for the test hole number, location, and surface elevation. Several logs may be shown on each sheet of form SCS–533. Where natural outcrops, streambanks, and gullies are used for logging and sampling, determine the elevation of the top of the outcrop and the location of the outcrop.

For "Hole Depth," show the depth in feet from the surface (0.0) to the bottom of the first stratum, or the depth from top to bottom of any underlying stratum. The description of materials should be complete, clear, and concise. Give the geologic designation that corresponds to the standard pattern used on the graphic log first and underline it, for example, "Gravel, silty."

Describe the sample particle size, shape, and composition. Include the approximate diameter of the average maximum-size particle. If possible, indicate the relative proportion of gravel, sand, silt, and clay. Describe particle shape as angular, subangular, and rounded. Note the principal constituents of the larger particles, such as gneiss, limestone, granite, sandstone, and quartz. Indicate the presence of diatoms, gypsum, iron oxides, organic matter, platy minerals such as micas, and others that may have an influence on engineering properties.

Record color, consistency, and hardness. For fine-grained soils, note relative plasticity, dry strength, and toughness. Indicate the relationships shown by stratification, such as "varved clay" and "interbedded sand and gravel." Indicate the presence of joints and their kind, spacing, and attitude if they can be determined. Indicate consistency or degree of compactness of the materials. Record the SPT blow count. Where possible, note the genesis, such as alluvium, lake deposits, and glacial till.

For consolidated rock, include kind of rock, degree of weathering, cementation, and structural and other features in the description. Include the geologic name and age of the formation if it is known. Use the scale of rock strength to describe the ease of excavation. Show the USCS symbol as determined by field tests. A column is provided for a description of type and size of sampler used for sampling or advancing a hole. Examples are bucket auger, tube, stationary-piston sampler, double-tube soil-core barrel type, or double-tube rock-core barrel. The abbreviations that should be used for the different types of samplers are given in the following list in table 5–2.

Columns are provided for sample data. It is important to show the sampling horizon and whether the sample is disturbed (D), undisturbed (U), or rock core (R). Show the sample recovery ratio (S), which is equal to L/H where L is the length of sample recovered and H is the length of penetration, as a percentage. This may be an important factor in the determination of fissures, cavities, or soft interbedded materials in consolidated rock.

(c) Field notes

Data can be logged directly on the standard form or in a separate notebook. Field notes should contain all the data for both graphic and written logs and also any information used to make interpretations but not entered in the log. Items to be considered in logging a test hole are shown in table 5–3. Original field notes and logs must be preserved in the project file.

Table 5–2 Abbreviations for sampling methods used in logs of field testing and sampling

Sampling method	Abbreviation
Bucket auger	BA
Thin-wall open-drive (Shelby)	S
Split-tube sampling spoon	SpT
Stationary piston	Ps
Piston (Osterberg type)	Pf
Dry barrel	DB
Double-tube soil-core barrel (Denison)	D
Single-tube rock-core barrel	RCs
Double-tube rock-core barrel	RCd
Hand cut	HC

Table 5–3 Log entries of earth materials

Item	Description
Hole number, location, and surface elevation	Number holes in the sequence in which they are drilled within each area of investigation. These areas have been assigned standard hole numbers. Show test hole location by station number or by reference to a base. Show elevation above MSL, if it is known, or elevation from an assumed datum.
Depth	Record the depth to the upper and lower limits of the layer being described.
Name	In unconsolidated materials, record the name of the primary constituent first, then as a modifier the name of the second most prominent constituent; for example, sand, silty (two constituents are enough). If it is desirable to call attention to a third, use the abbreviation w/ after the name; for example, sand, silty w/cbls (with cobbles).
Texture	Record size, shape, and arrangement of individual minerals or grains. In consolidated rock, descriptive adjectives are usually sufficient. In unconsolidated material, use descriptive adjectives for size and give an average maximum size in inches or millimeters. Record shape by terms such as equidimensional, tabular, and prismatic and by the degree of roundness. Record arrangement by estimated relative amounts. Record the gradation for coarse-grained, unconsolidated materials and the sorting for poorly graded materials.
Structure	Describe features of rock structure observed, such as bedding, laminations, cleavage, jointing, concretions, or cavities. Where applicable, include information on size, shape, color, composition, and spacing of structural features.
Color	Record color for purposes of identification and correlation. Color may change with water content.
Moisture content	Note whether the material is dry, moist, or wet.
Mineral content	Record identifiable minerals and the approximate percentage of the more abundant minerals. Describe any mineral that is characteristic of a specific horizon and record its approximate percentage even though it occurs in very minor amounts. Record the kind of cementation if present.
Permeability	Estimate the relative permeability and record it as impermeable, slowly permeable, moderately permeable, or rapidly permeable. If a field permeability test is run, describe the test and record the results.
Age, name, and origin	Record geologic age, name, and origin, for example, Jordan member, Trempeleau Formation, Cambrian age; Illinoian till; Recent alluvium. Use the term “modern” for sediments resulting from culturally accelerated erosion. Distinguish between Recent and modern deposits. For valley sediments, record its apparent genesis. Such identification helps in correlation and in interpreting data from test holes. Similarly, knowing that a material is of lacustrine or eolian origin or that it is a part of a slump or other form of mass movement helps in evaluating a proposed structure site.
Strength and condition of rock	Record rock condition by strength, degree of weathering, and degree of cementation.
Consistency and degree of compactness	Describe consistency of fine materials as very soft, soft, medium, stiff, very stiff, and hard. Describe degree of compactness of coarse-grained soils as very loose, loose, medium, dense, and very dense.
USCS symbol	Assign a USCS symbol for all unconsolidated materials. Borderline materials are given hyphenated symbols, such as CL–ML and SW–SM. Ordinarily, this borderline classification cannot be determined in the field. If there is doubt about the proper classification of material, record it as “CL or ML” and “SW or SM” and not by the borderline symbols. Record the results of field-identification tests, such as dilatancy, dry strength, toughness, ribbon, shine, and odor.
SPT blow count	For standard penetration test (SPT), record the results and the test elevation or depth. See section on SPT later in this chapter for SPT procedures. This test shows the number of blows under standard conditions that are required to penetrate 12 inches or, with refusal, the number of inches penetrated by 100 blows. The latter is commonly recorded as 100/d, where d equals the number of inches penetrated in 100 blows.
Other field tests	If other field tests are made, record the results and describe each test completely. Examples are vane-shear test, pressure test, field density test, field tests for moisture content, acetone test, and the use of an indicator such as sodium fluorescein dye to trace the flow of groundwater.
Miscellaneous information	Record any drilling difficulties, core and sample recovery, losses, and reasons for losses, type and mixture of drilling mud used to prevent caving or sample loss, loss of drilling fluid, and any other information that may help in interpreting the subsurface condition.
Water levels	Record the static water level and the date measured. Wait at least 1 day after the hole has been drilled to measure the water level to allow time for stabilization.

631.0503 Sampling earth materials

(a) Exposed profiles

(1) Natural exposures

A complete investigation of earth materials in natural exposures at the surface is necessary to provide a basis for guiding subsurface investigations, testing, and sampling. Natural exposures, when described in detail, serve the same purpose as other logs in establishing stratigraphy and other geologic conditions. A fresh surface is required for the preparation of adequate descriptions. An ordinary hand shovel or geologist's pick may be required for preparing the surface of a natural exposure for accurate logging.

(2) Trenching and test pitting

Trenching and test pitting are simple methods of shallow exploration of easily excavated rock or soil materials. Visual inspection of a wide section of strata is of great value in logging profiles and selecting samples. If bedrock is anticipated at a shallow depth, trenches and test pits should be located on the centerline of the proposed structure and dug parallel with it. If bedrock is not at shallow depths, deep trenches or test pits should be offset from the centerline to avoid damaging the foundation of the structure. Shallow trenches or test pits may be dug adjacent to the centerline for correlation purposes.

Where pits or trenches penetrate or pass through foundation materials, trenches are backfilled and compacted to the density of the original in-place material. It is recognized that certain limitations exist in the use of trenching and test-pit excavating equipment for compacting fill material. However, every practical effort should be made to reestablish the in-place densities of foundation materials.

Trenches—Trenches are long, narrow excavations. They are advantageous for studying earth materials on steep slopes and in exposed faces. Trenches made by power equipment, such as backhoes, power shovels, and bulldozers, may require hand trimming of the sides and bottom to reach relatively undisturbed material. The method is of particular value in delineating the rock surface beneath the principal spillway and in abutments and in exploring auxiliary spillway materials. Trenching may be the most feasible method of investigation in materials containing cobbles or boulders. Trenches may yield valuable information on potential rock excavation and core trench depth along the centerline of the structure, depending on its design.

Test pits—Test pits are large enough to accommodate a person with sampling equipment. They may be excavated by hand or by power equipment such as a clamshell or orange-peel bucket. Power equipment should be used only for rough excavation and with extreme caution when approaching the depths at which undisturbed samples are to be taken. Cribbing is required in trenches and pits of depths of 5 feet or greater (see exhibit 5–1).

(3) Procedures for obtaining undisturbed samples from exposed profiles

Undisturbed hand-cut samples can be obtained from exposed profiles above the water table. Undisturbed samples may be obtained as box, cylinder, or chunk samples.

Box samples are hand-cut and trimmed to cubical dimensions and placed in individual boxes for handling and shipping. They should have a minimum dimension of 6 inches.

Cylinder samples from 4 to 8 inches in diameter and 6 to 12 inches long can also be hand-cut by sliding a cylinder over a column of soil, which is trimmed to approximate size in advance of the cylinder. Cylinder samples may also be obtained by jacking or otherwise pushing drive samples into exposed surfaces using a continuous steady pressure. Hydraulic power equipment may also be used to push Shelby tubes into exposed undisturbed soil to collect undisturbed samples, such as the sampler mounted on a backhoe in figure 5–2.

Chunk samples are of random size and shape and are broken away from the soil mass with or without trimming.

They are difficult to package and ship but are simple to obtain.